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Electrostatic coating

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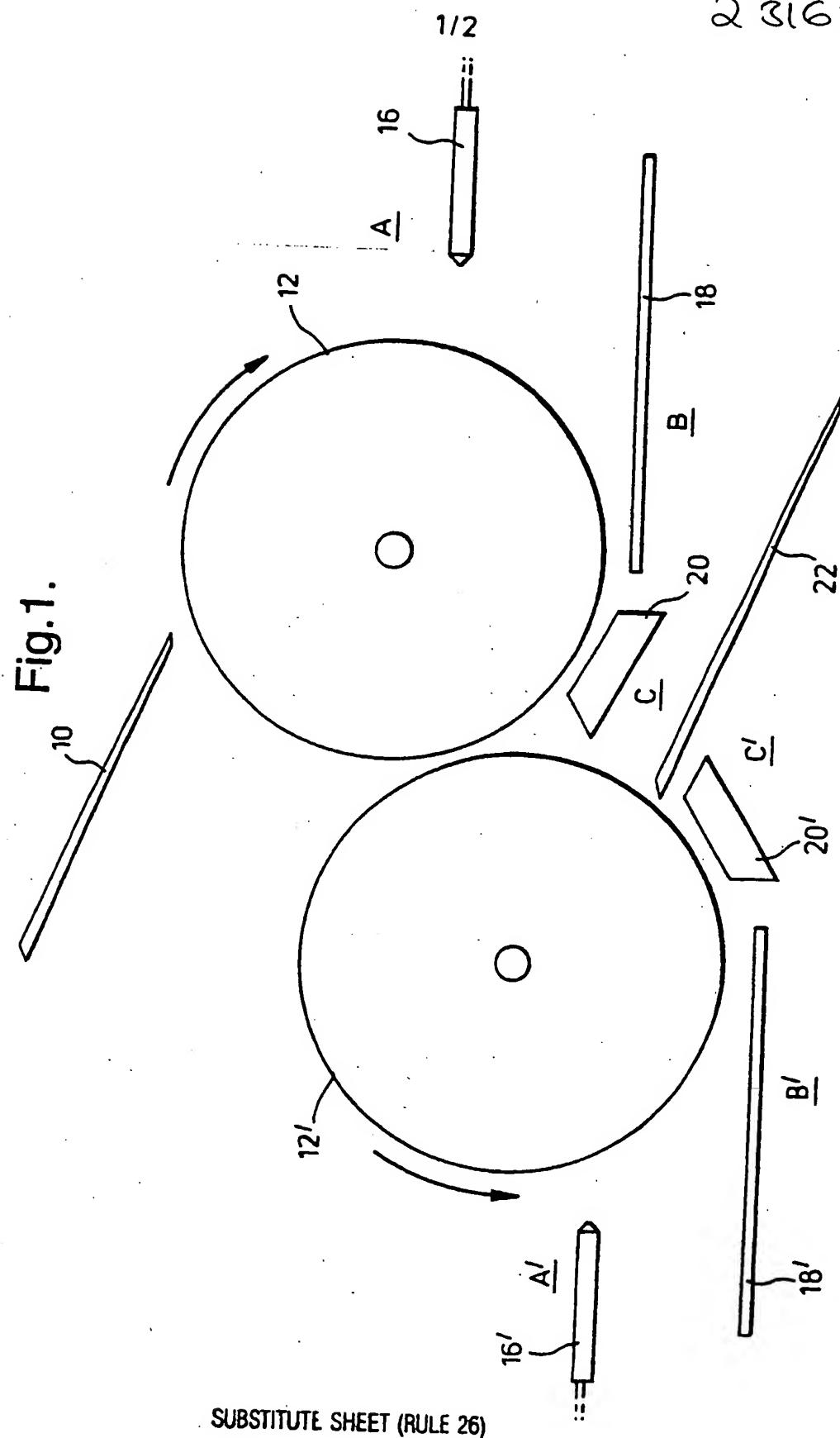
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Fig.2.

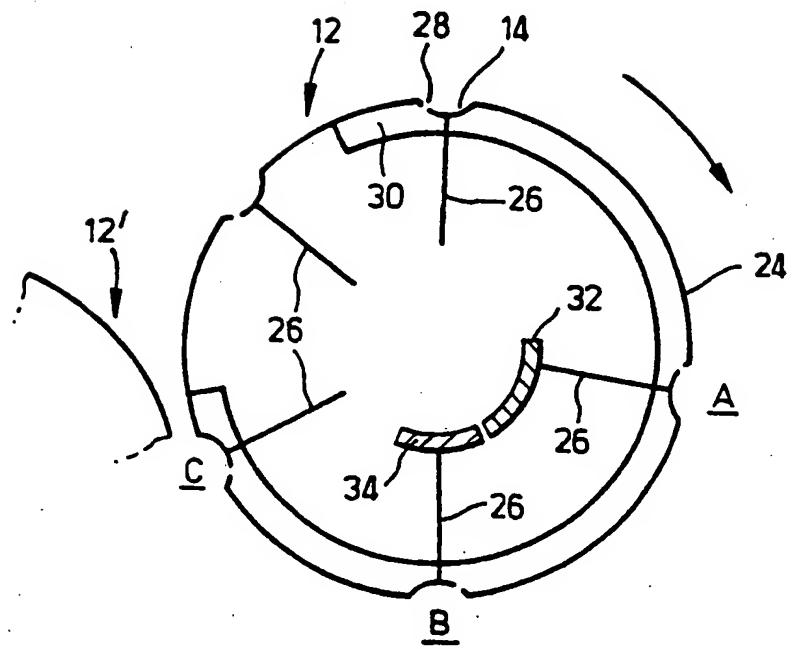
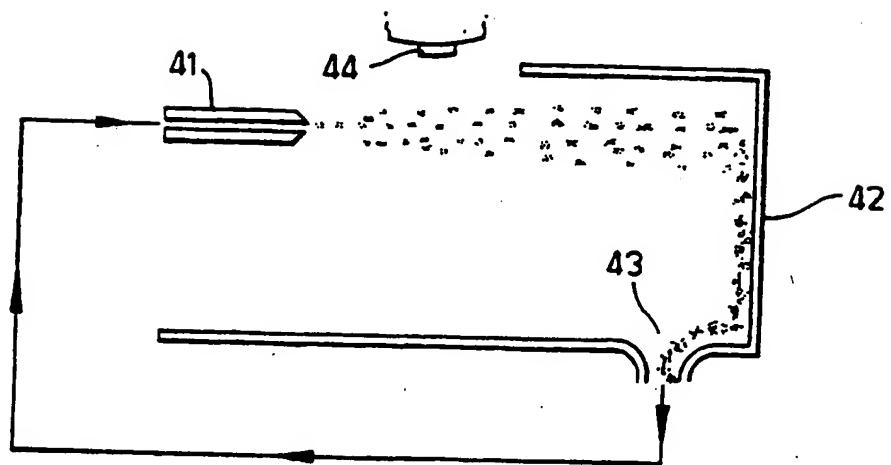


Fig.3.



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Electrostatic Coating

The present invention relates to a method and apparatus for producing a plurality of coated substrates, 5 each comprising an electrically poorly conducting substrate electrostatically coated by coating material. It finds particular application in the coating of solid pharmaceutical dosage forms such as tablet cores, capsules, granules and beads with particulate coating materials, 10 including powders and droplets of liquid.

The use of electrostatic techniques to coat electrically conductive substrates, such as metal objects, is well known and successful. The coating, such as droplets of liquid paint, is electrically charged by 15 applying a potential difference to it and is attracted to the earthed substrate.

The conventional electrostatic coating technique described above has not been successfully applied to the coating of pharmaceutical tablet cores or other poor 20 electrical conductors, generally those with a resistivity of more than $10^{10} - 10^{15} \Omega\text{m}$. Proposals have been made in which tablet cores are earthed, and a powdered coating material is directed at them through a nozzle which imparts an electrical charge to the powder. The powder coating is 25 then fused to give a uniform coat. This method has been found inefficient, since adequate earthing of the cores has not been achieved, and the charge on the powder accumulates on the surface of the cores, repelling further charged powder. Even if the cores are carried on for example an 30 earthed conveyor belt, the poorly conducting nature of the cores allows charge to build up.

Further, the bulk of the powder (95% in the case of corona charging) is uncharged, and does not land or stay on

the cores, and must either be recovered or wasted. These difficulties lead to non-uniformity in the weight and thickness of the coating applied to the cores. This is pharmaceutically unacceptable, in particular when the core 5 coating plays a significant role in the timing of the release of the pharmaceutical into the body after ingestion.

Improvements have been proposed, for example in WO 92/14451 which proposes moistening the cores with water 10 prior to spraying with the charged powder, to improve the earthing of the surfaces of the cores and to encourage the powder, once on the surfaces, to remain. Even with these improvements, coating remains inherently inefficient; powder is wasted and the time necessary for complete 15 coating is too long for efficient production.

The present invention overcomes these problems by providing a method of producing a plurality of coated substrates, each comprising an electrically poorly conducting substrate electrostatically coated by coating 20 material, the method comprising carrying the substrates on a support surface to a coating station at which they are held adjacent a source of particulate coating material, each substrate being associated with an individual location provided on the support surface which is electrically 25 isolated from the remainder of the surface, and holding the substrates and the coating material at a potential difference to each other sufficient to coat the exposed surface of each substrate.

Preferably, each substrate is held at a potential 30 difference to earth.

It is particularly preferred that the electric field between the coating material and each substrate is shaped. The field can be shaped so that each substrate is in a potential well. That is, each substrate is surrounded by a

potential difference to earth different to its own, there being a sharp cut-off between the two potential differences. Thus, substantially all the coating material is attracted to the substrates, reducing waste of the 5 coating material and avoiding the problems associated with coating material falling on the substrate surroundings.

Shaping of the field is achieved by manipulation of the potential difference between the substrates, their 10 surroundings and the coating material. For example, each substrate is carried by but insulated from a surface, the surface being held at the same potential difference to earth as the coating material while each substrate is held at a different potential difference to earth to that of the 15 coating material. Coating material is therefore attracted to the substrates and not to the surface.

Preferably, while coating takes place each substrate is in contact with an electrode through which it is maintained at a potential difference to earth (and to its 20 surroundings). The substrate may sit in a depression in the support surface. The surface of the depression can be of a conductive material and form part of the electrode. The support surface may be surrounded by an arrangement of insulating, conducting or semiconducting areas which act to shape the electrical field pattern. Each substrate is thus 25 surrounded by a potential well, to ensure that charged particles of coating material are attracted to it, rather than to the support surface.

Preferably, substantially the only motive force between the substrate and the coating material is 30 electrostatic. It may be desirable to provide particulate coating material in the form of a cloud of particles, formed for example by fluidising a bed of the coating material. Also preferably, each substrate is supported on

an electrode while being electrically isolated from its surroundings.

For powder coating applications, the substrates may be brought to a pretreatment station at which the exposed

5 surface of each substrate is coated with a capture-enhancing liquid. After coating with the coating material, the substrates can be brought to a heating station where the coating material if powder is fused or if liquid is dried to an effectively continuous uniform coating. The

10 reverse surfaces of the substrates can then be coated in the same way with the same coating material as the first-coated surface or with a different material. In this way, for example bi-coloured coated substrates may be produced. Preferably, the method is carried out continuously.

15 It is preferred that powder used in the method according to the invention has a resistivity greater than $10^8 \Omega\text{m}$, preferably between 10^8 and $10^{15} \Omega\text{m}$.

The present invention further provides an apparatus for producing a plurality of coated substrates, each

20 comprising an electrically poorly conducting substrate electrostatically coated by coating material, the apparatus comprising a support surface for carrying the substrates to coating station at which the substrates are held adjacent means for supplying particulate coating material, the

25 support surface being provided with a plurality of individual locations, each of which is electrically isolated from the remainder of the surface, and means for holding the substrates and the particulate coating material at a potential difference to each other.

30 Preferably, each substrate is held at a potential difference to earth.

Preferably, an electric field shaping device is associated with each substrate. Particularly preferably, the electric field shaping device surrounds the substrate.

Advantageously the support surface is conductive. A field shaping device can be provided by provision for the support surface to be held at a potential difference to earth having the same sign as the potential difference to earth of the coating material.

In the case of powder coatings, the apparatus can include a pretreatment station for supplying capture-enhancing liquid to the exposed surface of each substrate and a conveyor for conveying the substrates between the pretreatment station and the coating station, the pretreatment station being upstream of the coating station.

15 The conveyor is preferably a drum. The apparatus preferably includes a heating station downstream of the coating station for fusing the powder or drying the liquid coating material on the substrate to a film.

The present invention further provides a drum for use as a support surface in an apparatus according to the present invention, the circumferential surface of the drum comprising a plurality of individual locations, each of which is electrically isolated from the remainder of the drum surface.

25 The present invention further provides a coated pharmaceutical having one coating on one face and a different coating, or no coating, on the other face, the coated pharmaceutical being produced by the method of the present invention. The coatings may be of different colours or of different polymers or biologically active materials.

30 The source of particulate coating material, whether powder or liquid, may be a multiple source comprising several sub-sources. The sub-sources can be of different

colour coating materials or of coating materials containing different polymers. Thus, tablets having more than one colour on a single surface can be provided. The faces can be bicoloured or striped. Similarly, a tablet can carry 5 two or more different polymer coatings, side by side.

The present invention further provides a coated pharmaceutical on the surface of at least one face of which are two or more adjacent different coatings, the coated pharmaceutical being produced by the method of the present 10 invention. The coatings may be of different colours or of different polymers or biologically active materials.

The invention will be further described, by way of example, with reference to the drawings, in which:

15 Figure 1 shows schematically a preferred embodiment of apparatus according to the invention;

Figure 2 shows diagrammatically a cross-section of a drum of the apparatus of Figure 1; and

20 Figure 3 shows diagrammatically means for providing droplets of liquid coating material for an apparatus according to the invention.

The apparatus shown schematically in Figure 1 is for coating both sides of pharmaceutical tablet cores. The apparatus comprises an inclined tablet core feed chute 10 leading to a first rotatable drum 12. The drum 12 is of 25 plastic with a steel surface and has circular depressions 14 (Figure 2) in its outer

surface in each of which a core can be held by vacuum, as will be explained later.

The drum 12 is rotatable in the direction shown by the arrow in Figure 1. Adjacent the circumference of the drum 12 downstream of the tablet feed chute 10 is a pre-conditioning station A comprising an electrostatic spray gun 16, which produces charged droplets which are attracted to the substrate cores on the drum by reason of the potential difference between the droplets and the cores. Downstream of the preconditioning station A is a coating station B comprising a vibrating powder tray 18 for holding, fluidising and re-circulating the powder with which the cores are to be coated. Downstream of the coating station is a fusing station C comprising a heater 20. After the fusing station C, the coated core passes a cooling station, not shown, where cool air is directed over or around the core to cool the fused coating.

A second drum 12' is adjacent the first drum 12, the nip between the drums being downstream of the fusing station C and the cooling station. The second drum 12' rotates in the opposite sense to the first drum 12, as indicated by the arrow in Figure 1. The second drum 12' is provided with a preconditioning station A' comprising a gun 16', a coating station B' comprising a powder tray 18', a fusing station C' comprising a heater 20' and a cooling station (not shown).

A core collection chute 22 inclines away from the second drum 12' downstream of the fusing station C', taking coated cores to be further processed and packed.

The first drum 12 will be described in more detail with reference to Figure 2. It comprises a rotatable shell 24, the outer face of which carries the depressions 14. In Figure 2, only five exemplary depressions 14 are shown; it will be appreciated that in practice there will usually be more depressions, evenly spaced in a circumferential row around the shell 24, and that there may be several circumferential rows across the width of the

drum, whether formed by one continuous shell or several contiguous shells. The depressions 14 on the drums are shaped and dimensioned to ensure that the complete face of the core and half the depth of the side wall is coated while the core is on one drum. In the case of a circular tablet core, a depression diameter close to that of the core diameter is preferred. In some applications, the depth of the depression should be such as to allow at least 50% of the core thickness to be exposed to the particles of the coating material so that exposure of first one face of the core and then the other leads to complete coverage of the core.

The surface of each depression 14 is electrically insulated from the surfaces of other depressions on the drum and is provided with a pick up arm 26 extending radially inward, toward but ending short of the centre of the drum. The pick up arms 26 are attached to the inner surface of the shell 24 and rotate with it.

The pick up arm 26 and the depression 14 together make a moving electrode to charge a core in a depression. Each depression 14 has means for holding the core against forces such as gravity, for example a passage 28 through its wall which can be in communication with a vacuum manifold 30 which extends around a portion of the periphery of the drum interior from immediately upstream of the core feed chute 10 to adjacent the nip between the first drum 12 and the second drum 12'.

A first, earthed, stationary arcuate electrode 32 is located inside the drum at an angular position corresponding to the preconditioning station A. A second stationary arcuate electrode 34 at a potential difference to earth is located inside the drum at an angular position corresponding to the coating station B. The outer arcuate surfaces of the stationary electrodes are at the same radial distance from the centre of the drum as the free ends of the pick up arms 26 of the moving electrodes. As the shell 24 rotates, the moving electrodes contact the first and second stationary electrodes sequentially.

The drum 12 is held at a potential difference to earth having the same sign as the potential difference to earth of the coating powder.

The second drum 12' is constructed similarly to the first drum, comprising a rotatable shell with depressions, pick up arms, first and second stationary electrodes and a vacuum manifold. The angular locations of the first and second stationary electrodes correspond to the second preconditioning station A' and the second coating station B', and the vacuum manifold extends from immediately upstream of the nip between the two drums to adjacent the core collection chute 22.

In use, cores are fed continuously to the core feed chute 10. A core passes down the core feed chute 10 into a depression 14 in the rotating shell 24 of the first drum 12. At that angular position, the depression overlies the vacuum manifold 30, and so the core is held in the depression by the vacuum through the passage 28 in the shell. The shell 24 continues to rotate bringing the core to the preconditioning station A, at which point the pick up arm 26 attached to the depression 14 contacts the first stationary electrode 32, earthing the moving electrode and thus the core held in the depression. As the earthed tablet core passes the electrostatic spray gun 16, its exposed surface is sprayed with charged droplets of a capture-enhancing liquid, for example polyethylene glycol.

The shell 24 continues to rotate, taking the moving electrode 26 out of contact with the first stationary electrode 32 and bringing it into contact with the second stationary electrode 34, as the tablet core approaches the coating station B. The exposed polyethylene glycol treated core surface is now at a potential difference to earth, and coating powder is attracted to it from the powder tray 18. The potential well generated by holding the surface of the drum and the powder at the same potential difference to earth as each other and the core at a different potential difference to earth ensures that powder is

attracted substantially only to the core and that the surface of the drum remains substantially free of powder.

The shell 24 continues to rotate, taking the moving electrode 26 out of contact with the second stationary electrode 34 and bringing the core to the fusing station C, where the heater 20 fuses the powder on the coated surface of the core to form an effectively continuous film.

As the shell 24 continues to rotate, the core leaves the fusing station C, passes through the cooling station (not shown), so that the depression carrying the core no longer overlies the vacuum manifold 30. The core drops from the first drum 12 into a depression on the outer surface of the second drum 12', with its uncoated surface uppermost; the depression is in communication with the vacuum manifold of the second drum. The coating of the core is completed as it travels past the second preconditioning A', coating B' and fusing C' stations. The coating powder at the second coating station may be the same as that at the first, or different. Thus, tablets having differently coated surfaces can be produced. Such dissimilar coatings can be used to provide functionally modified behaviour such as altered diffusion or dissolution controlled drug release or cosmetically different coatings such as those which would produce a bicoloured tablet. As the coated tablet draws adjacent the collection chute 22, the depression carrying it ceases to overlie the vacuum manifold, and the tablet falls into the chute and is further processed and packed.

The drums themselves are preferably at least 60 mm in diameter and not less than the minimum tablet diameter in width, rotating at least 1/2 r.p.m. The pressure in the vacuum manifold is sufficiently low to hold the tablet against gravity, preferably between 0.2 and 0.5 bar absolute.

In the electrostatic spray guns 16,16' at the preconditioning stations A,A', a semiconducting, non-volatile fluid, such as polyethylene glycol or an in aqueous solution

thereof is fed at a rate of 0.1 to 1 ml/min. to a steel capillary of internal diameter 0.05 to 2 mm. The capillary is connected to a current limited high voltage (up to 50 kV at 30 to 100 μ A) potential difference to earth as each core on a drum passes the gun, and a mist of charged droplets is discharged from the capillary toward the core on the drum; since the cores on the drums are earthed at the preconditioning stations, the charged droplets are guided by the electric field between the capillary and the core to the exposed surface of the core, where they are captured. The cores may be held at a potential difference to earth at the preconditioning stations, providing that they are also at a potential difference to the capillaries. In this case, the first stationary arcuate electrode 32 is at a potential difference to earth. The supply of droplets from each capillary is controlled by switching the voltage off and earthing the capillary through a resistor (1 to 10 M Ω) as each core leaves the preconditioning station; this ensures a sharp cut off of the droplets between tablet cores.

The pre-conditioning step may not always be required.

At coating stations B,B', powdered coating material is supplied by vibrating feeders to the vibrating trays 18,18'. The level of the powder in the trays is determined by a levelling blade above each tray. The powder may be vibrofluidized and continuously recirculated. The trays may be of a plastics material having an earthed metal strip under the arc swept by the tablet cores on the respective drums or they may be metallic trays. An alternative way to charge the particles is triboelectrical charging. The trays are preferably 50 to 150 mm long and 3 to 40 mm wide. If more than one tray is used, to provide a bi- or multicoloured face or a face carrying more than one polymer composition, the tray dimensions will be appropriately different. The tablet cores are charged by a voltage of -3 to -15 kV current limited to 5 μ A.

A preferred powder coating composition is:

46.5% by weight Eudragit (RTM) RS ammonio-methacrylate
co-polymer

28.0% by weight Klucel (RTM) hydroxy propyl cellulose

15.0% by weight titanium dioxide

5.0% by weight aluminium lake

5.0% by weight polyethylene glycol 6000

0.5% by weight Aerosil (RTM) 200 colloidal silicon dioxide

Another preferred powder coating composition is:

39.75% by weight Eudragit RS ammonio-methacrylate

co-polymer

39.75% by weight Klucel (hydroxypropylcellulose)

15.0% by weight Titanium dioxide

5.0% by weight Aluminium lake

0.5% by weight Aerosil (colloidal silicon dioxide)

The components are premixed under high shear, then wet granulated by mixing under high shear with water (10-15% by weight). The granulated mixture is dried in a fluid bed drier at about 45° for 20 to 30 minutes to reduce the moisture content to below 3% by weight. The dried granules are milled and micronised to a powder having a size distribution such that 50% by volume of the particles are of a size less than 20 μ m, and about 100% by volume are of a size less

than 60 μm . The peak size is about 10 μm . The preferred powder coating compositions are claimed in British Patent Application No. 97 23708-5.

If the particulate coating material is liquid droplets, the apparatus is of a similar construction to that for applying powdered coating material to the cores. The vibrating trays holding the powder are replaced by means for producing liquid droplets with low momentum, such as that shown in Fig. 3. The apparatus may be designed so that a source of powder coating material may be easily replaced by a source of droplets of liquid coating material.

Droplets are produced by a spray gun 41 held at earth potential and electrically connected to the drum (12). The gun may be formed of metal or a polymer material. The direction of the spray is towards a baffle 42 down which the coalesced droplets can run into a re-circulating reservoir 43. The spray gun 41 produces a spray of relatively high initial momentum. This impinges on an internal baffle which breaks the spray up into a mist of droplets of low momentum. The momentum of the droplets produced by the spray gun is mainly in a direction normal to the substrate 44. If the substrate is uncharged there will be effectively no droplet capture onto the substrate surface. When the charge is applied to the substrate surface the droplets are attracted thereto to form a coating thereon which is later dried at a drying station similar to the fusing station C of the powder treatment apparatus. The pre-conditioning step A may be omitted in the case of liquid coating material.

A preferred liquid coating composition comprises:

hydroxypropylmethylcellulose	70%
glycerol	7%
iron oxide yellow	23%

in aqueous dispersion.

At the fusing or drying stations C,C', energy is imparted to the core surfaces to fuse the powder or dry the liquid and provide a uniform coating on the exposed surfaces of the core. The energy is provided by focused radiation preferably in the infra-red region; the energy power requirement will be determined largely by the coating material. After fusing or drying, the coating is set by cooling, using an air blower.

Preferred coating apparatus according to the invention can coat up to 300,000 tablet cores each hour.

CLAIMS :

1. A method of producing a plurality of coated substrates, each comprising an electrically poorly conducting substrate electrostatically coated by coating material, the method comprising carrying the substrates on a support surface to a coating station at which they are held adjacent a source of particulate coating material, each substrate being associated with an individual location provided on the support surface which is electrically isolated from the remainder of the surface, and holding the substrates and the coating material at a potential difference to each other sufficient to coat the exposed surface of each substrate.
- 15 2. A method according to claim 1 in which each substrate is at a potential difference to the remainder of the surface.
3. A method according to claim 1 or 2 in which the electric field between the coating material and each substrate is shaped so that each substrate is in a potential well.
- 20 4. A method according to claim 1, 2 or 3 in which the remainder of the surface is electrically conductive.
- 25 5. A method according to claim 4 in which the potential difference to earth of the surface and of the coating material are of the same sign.
- 30 6. A method according to claim 4 or 5 in which the surface is at the same potential difference to earth as the coating material.

7. A method according to any preceding claim in which each substrate is held at a potential difference to earth.
8. A method according to any preceding claim in which substantially the only motive force between the substrates and the coating material is electrostatic.
5
9. A method according to any preceding claim in which each substrate is supported by, and in electrical contact with, an electrode, each substrate being otherwise electrically isolated from its surroundings.
10
10. A method according to claim 9 in which the support surface is continuous.
15
11. A method according to any preceding claim in which the coating material particles are at a potential different to earth.
12. A method according to any preceding claim in which a powdered coating material is used.
20
13. A method according to claim 12 further comprising bringing the substrate coated with powder to a fusing station where the powder on each substrate is fused to a uniform coating.
25
14. A method according to claim 13 in which the fusing is by heating.
- 30 15. A method according to claim 14 in which the heating is by infra-red radiation.

16. A method according to any of claims 13, 14 or 15 further comprising cooling the fused coating on the substrates.

5 17. A method according to any of claims 12 to 16 further comprising, prior to bringing the substrates to the coating station, bringing the substrates to a preconditioning station at which the exposed surface of each substrate is coated with a capture-enhancing liquid.

10 18. A method according to claim 17 in which the coating carried out at the preconditioning station is electrostatic coating.

15 19. A method according to claim 17 or 18 in which the capture-enhancing liquid is partially conducting.

20 20. A method according to any of claims 1 to 11 in which the coating material is liquid.

21. A continuous method according to any preceding claim in which the substrates are carried by a moving surface.

25 22. A continuous method according to claim 21 in which the substrates are carried by the surface of a rotating drum.

30 23. A continuous method according to claim 21 or 22 in which each substrate is held in a depression in the surface, the depression being electrically isolated from the remainder of the surface.

24. A method according to any preceding claim in which each substrate is held in contact with an electrode at least while it is at the coating station.

25. A method according to any preceding claim further comprising turning each substrate after application of a coating to a first surface of the substrate and applying a 5 coating to a second surface of each substrate.

26. A method according to any previous claim in which the substrates are solid pharmaceutical dosage forms.

10 27. A method according to claim 26 in which the substrates are tablet cores.

28. A coated substrate produced by a method according to any of claims 1 to 27.

15

29. Apparatus for producing a plurality of coated substrates, each comprising an electrically poorly conducting substrate electrostatically coated by coating material, the apparatus comprising a support surface for

20 carrying the substrates to a coating station at which the substrates are held adjacent means for supplying particulate coating material, the support surface being provided with a plurality of individual locations, each of which is electrically isolated from the remainder of the 25 surface, and means for holding the substrates and the particulate coating material at a potential difference to each other.

30 30. Apparatus according to claim 29 comprising means for holding a substrate at a potential difference to the remainder of the surface at the coating station.

31. Apparatus according to claim 29 or 30 in which an electric field shaping device is associated with each

substrate, and shapes the field so that the substrate is in a potential well.

32. Apparatus according to claim 31 in which the electric field shaping device surrounds the substrate.

33. Apparatus according to any of claims 29 to 31 in which the support surface is conductive.

10 34. Apparatus according to any of claims 29 to 32 in which the potential difference of the support surface to earth and of the coating material to earth are of the same sign.

15 35. Apparatus according to any of claims 29 to 33 comprising means for holding the support surface at the same potential difference to earth as the coating material.

20 36. Apparatus according to any of claims 29 to 34 comprising means for holding each substrate at the coating station at a potential difference to earth.

25 37. Apparatus according to any of claims 29 to 35 further comprising a fusing station downstream of the coating station for fusing a powdered coating material on each substrate to a film.

38. Apparatus according to claim 37 in which the fusing station comprises a heater.

30 39. Apparatus according to claim 38 in which the heater is a source of infra-red radiation.

40. Apparatus according to claim 37, 38 or 39 further comprising a cooling station downstream of the fusing station.

5 41. Apparatus according to claim 39 in which the cooling station comprises an air blower.

42. Apparatus according to any of claims 29 to 41 further comprising a preconditioning station for supplying capture-enhancing liquid to the exposed surface of each substrate and a conveyor for conveying the substrates between the preconditioning station and the coating station, the preconditioning station being upstream of the coating station.

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43. Apparatus according to claim 42 in which the preconditioning station comprises an electrostatic spray gun for supplying the capture-enhancing liquid.

20 25

44. Apparatus according to any of claims 29 to 43 comprising a plurality of electrodes each disposed to contact a substrate at the coating station.

45. Apparatus according to claim 44 in which the said electrodes form part of the support surface.

46. Apparatus according to any of claims 29 to 45 in which the support surface is continuous.

30 35

47. Apparatus according to claim 46 in which the support surface is a conveyor disposed between the coating and fusing stations to move the substrates from the coating station to the fusing station.

48. Apparatus according to claim 47 in which the conveyor is also disposed between the fusing and cooling stations to move the substrates from the fusing station to the cooling station.

5

49. Apparatus according to claim 47 or 48 in which the conveyor is also disposed between the preconditioning and coating stations to move the substrates from the preconditioning station to the coating station.

10

50. Apparatus according to any of claims 47 to 49 in which the conveyor is the outer surface of a rotating drum having discrete areas electrically isolated from the drum surface for the reception of respective substrates.

15

51. Apparatus according to claim 50 in which the said areas are depressions in the said surface of the drum.

20

52. Apparatus according to claim 50 or 51 in which the said areas are each part of a respective moving electrode, each moving electrode extending inside the drum, the drum further comprising a first arcuate stationary electrode so disposed inside the drum that as one of the said areas passes through the coating station the associated electrode is in electrical contact with the first stationary electrode.

25

53. Apparatus according to claim 52 in which, in use, the first stationary electrode is, in use, at a potential difference to earth.

30

54. Apparatus according to claim 52 or 53 further comprising a second arcuate stationary electrode so disposed inside the drum that as one of the said moving

electrodes passes through the preconditioning station it is in electrical contact with the second stationary electrode.

55. Apparatus according to claim 54 in which the second 5 stationary electrode is, in use, earthed.

56. Apparatus according to any of claims 50 to 55 further comprising a second drum and second coating and fusing stations, the second drum being so disposed relative to the 10 first drum that substrates leaving the first drum with a coated surface are transferred onto the second drum with an uncoated surface exposed.

57. Apparatus according to claim 56 further comprising a 15 second preconditioning station adjacent the second drum.

58. Apparatus according to any of claims 50 to 57 comprising a vacuum device for holding the substrates on the support surface.

20
59. A drum for use as a support surface in apparatus according to any of claims 29 to 58, the circumferential surface of the drum comprising a plurality of individual locations, each of which is electrically isolated from the 25 remainder of the drum surface.

60. A drum according to claim 59 in which the said individual locations are depressions in the surface of the drum.

30
61. A drum according to claim 59 or 60 in which the individual locations are each part of an electrode extending inside the drum, the drum further comprising a first arcuate stationary electrode so disposed inside the

drum that as, in use, the drum surface rotates around the first stationary electrode the moving electrodes move sequentially into and out of electrical contact therewith.

5 62. A drum according to claim 61 further comprising a second arcuate stationary electrode so disposed inside the drum that as, in use, the drum surface rotates around the second stationary electrode the moving electrodes move sequentially into and out of electrical contact therewith.

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63. A drum according to any of claims 59 to 62 further comprising a vacuum manifold in fluid connection with the said individual locations for holding the substrates on the drum.

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64. A solid pharmaceutical dosage form having one coated face and one uncoated face, the dosage form being produced by a method according to any one of claims 1 to 27.

20 65. A coated pharmaceutical having one coating on one face and a different coating on the other face, the coated pharmaceutical being produced by a method according to any one of claims 1 to 27.

25 66. A coated pharmaceutical on the surface of one face of which are two or more adjacent different coatings, the coated pharmaceutical being produced by a method according to any one of claims 1 to 27.

30 67. A coated pharmaceutical according to any of claims 65 to 66 in which the coatings are of different colours.

68. A coated pharmaceutical according to any of claims 65 to 67 in which the coatings contain different polymers.

69. A coated pharmaceutical according to any of claims 65 to 68 in which the coating contains biologically active material.

5 70. Apparatus for producing a plurality of coated pharmaceutical substrates, each comprising an electrically poorly conducting substrate electrostatically coated by coating material, the apparatus being substantially as described herein with reference to and as shown by the

10 drawings.

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